Response to comments by reviewer 1

We thank the reviewer for sharing their expertise and improving the manuscript.

Major Comments:
As Andrew Sayer is an expert on aerosol retrievals from satellite-based remote sensing, I strongly recommend the authors fully take his suggestions.

We agree with this major comment and have taken most of the Dr. Sayer's suggestions.

Kahn et al., 2005 describes validation of a previous version of the algorithm and should be replaced with Kahn et al., 2010. The title is "Multiangle Imaging SpectroRadiometer global aerosol product assessment by comparison with the Aerosol Robotic Network". Particle mixtures have changed, but many of the notes the authors have made about MISR remain valid.

We have used the more recent reference suggested by the reviewer. We now write in Sect. 4:

The MISR low bias may be related to the need for darker spherical particles (Kahn et al., 2010) given that forest fire smoke plays a significant role throughout western Canada in the warm season (O'Neill et al., 2002). Spherical particles with lower single scattering albedo (SSA) may also be required to properly represent local anthropogenic pollution (Kahn et al., 2010) in the AOSR.

Although the paper is focused on AOD trends from satellite-remote sensing, I would recommend also including an analysis of the Fort McMurray AERONET site as well.

The AERONET data record is short (2005-2015) at Fort McMurray and includes a missing year (2006) and three currently incomplete years (2005, 2007, and 2015). The record effectively spans 2008 to 2014, which is too short for trend analysis, given the large interannual variability.

Page 8, Line 18-19: The higher SNR is probably irrelevant over land (especially bright surfaces).

Most of the retrieved AODs used in the temporal correlation with the Fort McMurray AERONET site, at least by MODIS, are over dark vegetation. However, SNR is valuable both for dark and bright scenes. To first order, the bright surface does not affect the number of detected aerosol-scattered photons, it essentially affects the number of photons reflected by the surface. So while a bright scene has less noisy radiances, the fractional contribution by aerosol scattering decreases relative to a dark scene and greater SNR is required to be able to detect a typical, small AOD (e.g. 0.1 at 550 nm) with comparable AOD precision relative to a dark scene. In spite of this point, we agree that the SNR of all instruments is probably sufficient and the higher SNR is likely irrelevant.
Thus, the relevant sentence in the manuscript becomes:

Stronger short-term correlation with AERONET AODs reflects the superior spatial resolution of the MODIS radiances (Table 1).

PM2.5 Assessment:
I strongly recommend that the authors remove the AOD-to-PM2.5 aspect of this paper. I don't think it adds much to the paper, as the authors have in-situ PM2.5 data for 10 sites anyways, and the correlation between AERONET AOD and satellite remote sensing retrieved AOD is much higher than the correlation between NAPS PM2.5 and

satellite remote sensing retrieved AOD.

There are also a lot of caveats to converting between an integrated aerosol retrieval (AOD) and a surface aerosol retrieval (PM2.5), many of which I don't see discussed (please correct me if I missed it). Here are some of them:

1. For instance, MISR is viewing this area of the planet at roughly 10:15 AM local time. It is possible that the planetary boundary layer (PBL) is not always fully developed at this time, which would mean that a comparison between MISR AOD and surface based PM2.5 would not be possible.
2. Unmasked transported smoke that happens to be lofted above the PBL may not be seen by NAPS.
3. Variation in the PBL height from day to day and season to season will cause discrepancies between retrieved AOD and measured PM2.5 using a static ratio.
4. Large-scale differences in land-surface/water coverage may cause systematic discrepancies in PBL height at individual stations.

Although the results of the AOD-to-PM2.5 analysis show a positive trend in PM2.5 from space, I don't really see how useful this is, as the same thing can be shown from the 10 NAPS instruments with a much higher degree of confidence. Additionally, while I may trust the day-to-day changes in AOD retrieved from space, I would never put that kind of faith in converting AOD to PM2.5 on a daily basis. I recognize that the authors did not do this and are basically only using PM2.5 from AOD for yearly analysis, but some people may take this work and try to expand it in ways that probably shouldn't be done.

We agree with these comments. The AOD to $PM_{2.5}$ aspect can be avoided with the approach used in the revised manuscript. This involves correcting the POLDER/PARASOL and MODIS Deep Blue offsets (determined from the AERONET validation at Fort McMurray) and then calculating relative trends for AODs (from satellite) and for $PM_{2.5}$ (NAPS).

This is now described at p4L12:

For temporal trends, a simple linear regression is performed on relative anomalies derived from bias-corrected annual average and median AODs. The bias correction involves subtracting the AOD offset obtained through the validation with coincident Fort McMurray AERONET data.

General Comments:

Is it possible that the drop in 550 nm AOD (Figure 5) and NAPS PM 2.5 during 2015 is related to the fall in oil prices affecting activity in the region? If so, it may be worthwhile to note, as this would likely continue to the present day.

It is possible, but not likely, and this is too speculative in our opinion given that NAPS $PM_{2.5}$ data is not significantly different in 2013 and 2015 (see figure below illustrating oil prices over the past seven years). (http://www.nasdaq.com/markets/crude-oil.aspx?timeframe=7y).

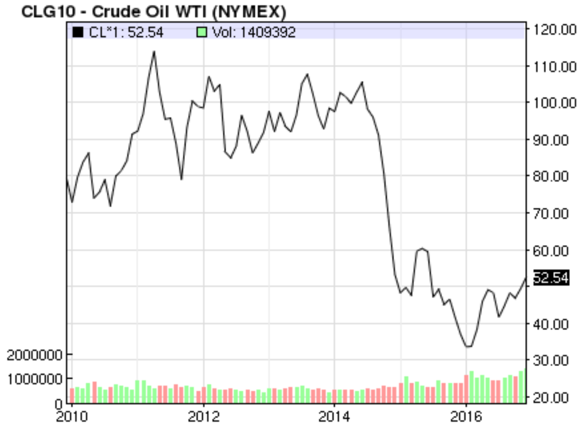

Figure 1: Figure 1 could be improved in a number of ways. In addition to what Andrew Sayer suggested, I recommend putting the locations of your AERONET sites and NAPS stations on the map (maybe as circles and stars). If you wanted to make the plots even more useful, you could color the circles and stars using the same color scale for AERONET, and a different scale for PM2.5.

The maps in Fig. 1 use all available satellite data, not just data that is coincident with $PM_{2.5}$ or AERONET observations. $PM_{2.5}$ is measured at night and in winter, when these satellite instruments do not measure. Similarly, the AERONET sites in the oil sands region measure all day, not just at the 1 or 2 local times per day of the satellite instruments and we have found diurnal variations in AOD of 30% at Fort McMurray based on AERONET data. Furthermore, AERONET has slightly more coverage during the cold season. To avoid these biases, in Fig. 1, we plot only the average AOD from satellite-coincident AERONET measurements. Both AERONET sunphotometers in the AOSR are collocated with NAPS sensors, so we chose AERONET over NAPS for Fig. 1. There is also the problem of a possible trend. The NAPS or AERONET data may cover a significantly shorter period (e.g. AERONET at Fort McKay started in 2013 whereas the POLDER map includes data from 1996). We leave Fort McKay out since the data record is too short for a reliable climatology of coincident AODs and has no temporal overlap with most of the sensors.

Figure 5: The authors should include the Fort McMurray AERONET site on this plot as well.

See response to earlier, related comment. No change is made to the manuscript.